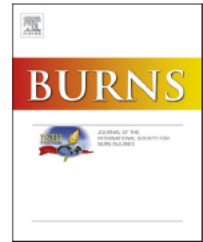


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A pilot review of gradual versus goal re-initiation of enteral nutrition after burn surgery in the hemodynamically stable patient

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ARTICLE INFO

Article history:

Accepted 16 February 2014

Keywords:

Enteral
Burn
Nutrition
Surgery
Calorie

ABSTRACT

Severe weight loss resulting from inadequate nutritional intake along with the hypermetabolism after thermal injury can result in impaired immune function and delayed wound healing. This observational study was conducted on adults admitted between October 2007 and April 2012 with at least 20% total body surface area burn requiring excision who previously tolerated gastric enteral nutrition at calorie goal and who returned from surgery hemodynamically stable (no new pressor requirement) and compared the effect of goal rate re initiation versus slow re initiation after the first excision and grafting. Demographic, intake, and tolerance data were collected during the 36 h following surgery and were analyzed with descriptive and comparative statistics. Data were collected on 14 subjects who met the inclusion criteria. Subjects in the goal rate re initiation group ($n = 7$) met a significantly greater percentage of caloric goals ($99 \pm 12\%$ versus $58 \pm 21\%$, $p = 0.003$) during the 36 h following surgery than subjects in the slow re initiation group ($n = 7$). There were no incidences of emesis, aspiration, or ischemic bowel in either group. The goal rate re initiation group had a 29% incidence of either stool output >1 L ($n = 1$) or gastric residual volumes >500 mL ($n = 1$), whereas these were not present in the slow re initiation group ($p = 0.462$). In conclusion, in this small pilot study, we found that enteral nutrition could be re initiated after the first excision and grafting in those patients who previously tolerated gastric enteral nutrition meeting caloric goals who return from surgery hemodynamically stable without a significant difference in intolerance and with a significantly higher percentage of calorie goals achieved, but larger studies are required.

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1. Introduction

Thermal injuries result in increased energy expenditure, catabolism, and loss of lean body mass [1–3]. Basal metabolic

rates may double [4–6], and severe weight loss resulting from inadequate nutritional intake along with this hypermetabolic, catabolic state can result in impaired antibacterial host defenses and delayed wound healing [1,2]. Multiple studies have shown that early post burn feeding results in increased

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<http://dx.doi.org/10.1016/j.burns.2014.02.015>
0305 4179/Published by Elsevier Ltd and ISBL.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 DEC 2014		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE A pilot review of gradual versus goal re-initiation of enteral nutrition after burn surgery in the hemodynamically stable patient				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Shields B. A., Brown J. N., Aden J. K., Salgueiro M., Mann-Salinas E. A., Chung K. K.,				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 6	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

provision of protein and calories; and improved outcomes include increased wound healing rates, decreased wasting, reduced length of stay (LOS), and reduced mortality [1,7–11]. To achieve the benefits of enteral nutrition (EN), the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Society of Critical Care Medicine (SCCM) recommend in their guidelines that EN be initiated within the first 24–48 h following admission and advanced to the goal rate over the next 48–72 h to provide greater than 50–65% of goal calories in the first week of hospitalization [6]. A retrospective review associated with the Glue Grant published in the *Journal of Burn Care and Research* in 2011 found that burn patients who had EN initiated within 24 h of admission had a shorter intensive care unit LOS and decreased incidences of wound infections ($p = 0.030$ and $p = 0.010$) [11]. Although the ASPEN/SCCM guidelines address timing for both initiation and achievement of goal rate for EN and the Glue Grant provides evidence for early initiation, there is insufficient evidence to support more specific recommendations on the rate of delivery at initiation [6]. Once a patient is considered hemodynamically stable (HDS), common practice is to slowly initiate and advance EN while monitoring for signs of feeding intolerance such as vomiting, diarrhea, abdominal distension, and gastric residual volumes (GRVs). The practice of slowly initiating EN is also often used with re-initiation of EN following interruptions for surgical procedures. This practice is not supported by evidence based research.

A prospective, randomized study by Desachy et al. in 2008 compared two early EN protocols in which EN goal rate was introduced either immediately or gradually [12]. This study showed that there was significant improvement in the amount of calories delivered with no difference in serious adverse events between groups. However, the group that received the EN goal rate immediately had GRVs greater than 300 mL more frequently than the group receiving calories gradually ($p = 0.04$). Although GRVs over 300 mL may have been described as elevated in the past, the ASPEN/SCCM guidelines recommend not holding EN for GRVs less than 500 mL [6]. Desachy's study examined the initiation of EN, not the re-initiation of EN after surgery.

The practice of goal rate initiation, and specifically goal rate re-initiation (GRR) (after a goal rate has been achieved previously), has not been thoroughly studied. Our facility has closely examined caloric deficits and over time has decreased these deficits. One method of decreasing these caloric deficits was to re-initiate EN at the previously achieved goal rate when the patient returns from surgery HDS.

The purpose of this study was to examine our change in practice and to compare the effect of the GRR of EN versus slow re-initiation (SR) in HDS post surgical burn patients on caloric provision, incidence of gastrointestinal (GI) complications, GRVs, and outcomes. We hypothesized that subjects in the GRR group would have improved caloric delivery and that there would be no difference between groups with feeding tolerance.

2. Methods

This retrospective review of a prospective, descriptive study included subjects who were 18 years or older, had a total body

surface area (TBSA) burn greater than or equal to 20%, and were admitted between October 1, 2007 and April 1, 2012. Subjects were excluded from this analysis if the EN calorie goal to achieve resting energy expenditure along with an activity factor of 1.2 was not achieved prior to the first surgical excision and grafting (E&G) (including instances where parenteral nutrition was used rather than EN or the subject consumed food orally). Because the change in clinical practice included only restarting at the previously tolerated goal for EN if the patient returned from surgery HDS, we excluded any subjects who had a new pressor requirement between return from surgery and initiation of EN. Only subjects who were being fed in the stomach (not post pyloric) were included because this was the case for the majority of the subjects. This study was approved by the local Institutional Review Board.

Clinically, the standard of care included placing a nasogastric feeding tube on the day of admission for all patients with burns exceeding 30% TBSA as well as those who were suspected to be unable to meet calorie goals through oral intake. Post pyloric feeding tubes were placed on a case by case basis at the physician's discretion. EN was initiated at 20 mL/h and then increased by 20 mL/h every 4 h as tolerated until the goal rate was reached. The Carlson and Milner equations were used to predict calorie expenditure [13,14]. The Milner equation was created for >30 days after injury, with the factor of number of days post burn added to the Carlson equation using linear regression [14]. We recently found the Carlson and Milner equations to be the most accurate in predicting resting energy expenditure, with the Milner equation having the lowest mean error [15]. Metabolic cart (VMAX Encore) study results, when they were able to be obtained, replaced predictive equation results to estimate calorie goals. Activity factors of 1.2–1.4 were used because these factors have been shown to maximize the retention of lean body mass and maintain weight, respectively [16]. High protein, high carbohydrate, low fat modular EN (0.94 or 1.5 kcal/mL) was provided because it has been shown to improve the net balance of skeletal muscle protein in burn patients [17]. EN was discontinued 4 h prior to surgery. The registered dietitian (RD) encouraged the minimization of time EN was held for procedures and advocated for GRR after surgery when the patient returned from surgery HDS. Upon return from surgery, EN was re-initiated at a rate lower than the previously tolerated goal rate and increased as tolerated until the goal rate was reached (SR group), or EN was re-initiated at the previously achieved goal rate (GRR group). The differences in these practices were largely due to new residents and/or nursing staff.

GRVs were monitored every 4 h. When GRVs were greater than 500 mL with EN appearance, EN was held and the physician was notified. EN continued if GRVs were greater than 300 mL and less than or equal to 500 mL, and GRVs were rechecked in 2 h. If after 2 h the GRVs remained greater than 300 mL with EN appearance, the EN was held and the physician was notified. Treatment for elevated GRVs included gastric motility agents and/or post pyloric feeding tube placement. Residuals were returned up to a maximum of 300 mL.

The following demographic, clinical, and outcome data were collected from the subject's electronic medical record: age, gender, admission date, injury date, days from injury to

first E&G, percentage TBSA burn, percentage of burn excised at first surgery, height, pre injury body weight, 24 h calorie goal determined by the RD, placement of the feeding tube, hours between completion of surgery and EN re initiation, hours between completion of surgery and achieving EN goal rate, lowest and average mean arterial blood pressures (MAPs) between return from surgery and re initiation of EN, total calories delivered during the three 12 h periods following return from surgery, GI complications (emesis, aspiration, stool output >1 L, and ischemic bowel), GRVs greater than 300 mL and greater than or equal to 500 mL, the highest measured GRV, ventilator days, intensive care unit (ICU) LOS, hospital LOS, and mortality. The re initiation group (GRR or SR) was determined by the initial rate after surgery being equal to the previously tolerated rate prior to surgery or a lower rate. The calories delivered in each 12 h period were compared against the calorie goal established by the RD and reported as percentage caloric achievement for each of the three 12 h periods following return from surgery. Cumulative percentage caloric achievement was recorded as a percentage of the calorie goal at 24 h and 36 h. Because it can be difficult to determine volume of emesis if not collected in a container and because both emesis and gastric residuals can be largely gastric and oral secretions, the calories missed from loss of the caloric content in the emesis or gastric residuals could not be taken into account. Caloric delivery was calculated from all calorie containing enteral or parenteral provisions such as calorie containing intravenous fluids, EN formulas, and supplemental modular protein. Age, pre injury body weight, percentage TBSA burn, days from injury until E&G, percentage TBSA of initial excision, hours between surgery and EN re initiation, hours between completion of surgery and achieving EN goal rate, 24 h calorie goal, average and lowest MAP between surgery, and EN re initiation and highest GRV within 36 h were expressed as mean \pm standard deviation. Gender was expressed as percentage. Kruskal Wallis test and Fisher's exact tests were used to determine whether there were any baseline differences between the two groups. The

Kruskal Wallis test was also used to evaluate the calorie delivery and percentage of goal calories achieved during three 12 h periods at 12, 24, and 36 h after return from surgery as well as cumulatively after 24 and 36 h, the highest GRV in 36 h after surgery, ventilator days, ICU LOS, and hospital LOS. Fisher's exact tests were used to evaluate for differences in the incidence of stool output >1 L, emesis, GRVs greater than 300 mL or greater than or equal to 500 mL, aspiration, any incidence of ischemic bowel during the subjects' hospital stay, and mortality. An alpha level of ≤ 0.05 was used to determine statistical significance. Statistical analyses were completed using Excel 2007.

3. Results

During the study period, 183 adults were admitted with >20% TBSA burn requiring excision. Of these subjects, 26 were on an oral diet, 1 was on TPN, 2 received their primary burn care (including the initial E&G) before being transferred to our facility, 20 died prior to E&G, 43 did not have EN initiated prior to E&G, 58 did have EN initiated but did not reach goal rate prior to E&G, 2 reached goal rate but had elevated residuals and had EN held prior to the first E&G, 4 were being fed past the pylorus, 9 required pressors after surgery, 4 were not consented, and 14 met the inclusion criteria and were included in the analysis (7 in the GRR group and 7 in the SR group).

Fourteen subjects (age 53 ± 16 with $38\% \pm 14\%$ TBSA burn, 14% women) were included in the analysis, 7 in the GRR group and 7 in the SR group. There were no significant differences between groups (Table 1). For the entire dataset of 14 subjects, EN was initiated 3 ± 3 h after return from surgery, with no significant difference between the two groups ($p = 0.609$). Goal rate was achieved 3 ± 2 h after surgery in the GRR group and 25 ± 8 h after surgery in the SR group ($p = 0.003$). The GRR group achieved a significantly higher percentage of the caloric goal in the first and second 12 h periods but a similar amount in the third 12 h period (Table 2). There was no

Table 1 – Subject and treatment characteristics in subjects returning from surgery hemodynamically stable^a

Subject characteristic	All (n = 14)	GRR (n = 7)	SR (n = 7)	P value
Age, years	53 \pm 16	47 \pm 16	60 \pm 15	0.110
Women, n (%)	2 (14%)	1 (14%)	1 (14%)	1.538
Height, in.	69 \pm 5	67 \pm 5	71 \pm 3	0.201
Pre injury weight, kg	84 \pm 18	76 \pm 15	92 \pm 17	0.180
TBSA burn (%)	38 \pm 14	32 \pm 10	43 \pm 17	0.125
TBSA of initial excision (%)	26 \pm 13	21 \pm 14	32 \pm 11	0.064
Days from injury to first excision	6 \pm 5	7 \pm 7	4 \pm 1	0.110
Calorie goal per day	3240 \pm 675	2954 \pm 564	3525 \pm 692	0.142
Hours delayed ^b	3 \pm 3	3 \pm 2	4 \pm 4	0.609
Hours to goal rate ^c	13 \pm 13	3 \pm 2	25 \pm 8	0.003 [*]
Average MAPs, mm Hg ^b	83 \pm 13	83 \pm 12	84 \pm 15	0.655
Lowest MAPs, mm Hg ^b	72 \pm 15	74 \pm 16	70 \pm 15	0.565

GRR, goal rate re initiation group; SR, slow re initiation group.

^a Data presented as mean \pm standard deviation or n (%).

^b Between surgery and EN re initiation.

^c One subject in SR not included, as death preceded goal rate.

^{*} $P < 0.05$.

Table 2 – Caloric delivery and percent caloric achievement in subjects returning from surgery hemodynamically stable.^a

Caloric data	All (n = 14)	GRR (n = 7)	SR (n = 7)	P value
<i>Caloric delivery (kcal)</i>				
0–12 h	819 ± 539	1228 ± 387	411 ± 300	0.002 [*]
13–24 h	1322 ± 557	1600 ± 399	1043 ± 577	0.025 [*]
25–36 h	1585 ± 491	1602 ± 542	1568 ± 478	0.848
<i>Caloric achievement (%)</i>				
0–12 h	53 ± 36%	83 ± 19%	22 ± 16%	0.002 [*]
13–24 h	84 ± 32%	108 ± 11%	60 ± 29%	0.003 [*]
25–36 h	99 ± 24%	107 ± 20%	91 ± 27%	0.277
<i>Cumulative achievement (%)</i>				
0–24 h	68 ± 32	95 ± 13%	41 ± 19%	0.002 [*]
0–36 h	78 ± 27	99 ± 12%	58 ± 21%	0.003 [*]

GRR = goal rate re initiation group.

SR = slow re initiation group.

^a Kruskal Wallis test, data presented as mean ± standard deviation.^{*} P < 0.05.

emesis, aspiration, or ischemic bowel in either group. Two of the subjects in the GRR group (29%) had an occurrence of either stool output >1 L (n = 1) or GRVs >500 mL (n = 1), whereas none of these were present in the SR group (p = 0.462). There were no significant differences in tolerance or outcomes (Table 3).

4. Discussion

The first two 12 h periods after surgery showed a significant difference in percentage of caloric achievement between groups. This difference translates into a caloric deficit of 2072 ± 844 kcal in the 24 h following the initial E&G for the SR group. This factor is one of the many contributors to the caloric deficit, which can ultimately result in severe weight loss and impair antibacterial host defenses and delay wound healing, especially when weight loss exceeds 10% [1,2]. We examined a one time deficit after the first E&G surgery, which does not include re initiation after supplementary E&G surgeries,

additional surgical interventions, and other interruptions in EN. The SR group had an average of 14 other interruptions in EN. If each instance resulted in a similar caloric deficit, these subjects would reach more than 5% weight loss just from continuing this strategy of SR of EN, not including time missed during the interruptions.

We are not aware of other studies examining the re initiation of EN after surgery. Other studies have evaluated the initiation of EN with increase to goal EN rate within 8 h [18], trophic versus full EN for six days [19], and multiple EN protocols during the ICU stay [20,21]. We believe that this is the first study to evaluate the re initiation of EN after surgery and believe that it will impact not just burn patients, but other surgical patients as well. We intend to perform another analysis with more subjects in order to determine if this practice results in improved outcomes.

Subjects were excluded from this analysis if the EN calorie goal to achieve resting energy expenditure along with an activity factor of 1.2 was not achieved prior to the first surgical excision and grafting (E&G), in order to minimize examining

Table 3 – Gastrointestinal complications within 36 h and overall subject outcomes in subjects returning from surgery hemodynamically stable.^a

Complication/outcome	GRR n = 7	SR n = 7	P value
Emesis	0 (0%)	0 (0%)	n/a
Stool output >1 L in 36 h after surgery	1 (17%)	0 (0%)	1
GRVs >300 mL	2 (29%)	1 (14%)	1
GRVs >500 mL	1 (17%)	0 (0%)	1
Highest GRV, mL (mean ± SD)	194 ± 185	115 ± 115	0.371
Aspiration	0 (0%)	0 (0%)	n/a
ischemic bowel	0 (0%)	0 (0%)	n/a
Ventilator days	34 ± 25	25 ± 21	0.701
ICU LOS	44 ± 29	37 ± 39	0.701
Hospital LOS	58 ± 43	57 ± 41	0.949
Mortality	3 (43%)	2 (29%)	1

GRR, goal rate re initiation group; SR, slow re initiation group; GRVs, gastric residual volumes; SD, standard deviation; ICU, intensive care unit; LOS, length of stay.

^aFisher's exact test, data presented as mean ± standard deviation or n (%).

subjects who were not tolerating EN prior to going to surgery. This is a pilot analysis is small subset (8%) of the total number of admissions during this time period with at least 20% TBSA burn requiring excision. Subjects in this study were not randomized because of the study's observational design.

5. Conclusion

In those subjects who achieved caloric goal with EN prior to the first E&G surgery, we found significant differences in the caloric achievement in the GRR group compared to the SR group. There were no negative clinical outcomes of emesis or aspiration or ischemic bowel in either group. There was no significant difference in ventilator days, ICU LOS, hospital LOS, or mortality. Future studies with larger sample sizes are needed with the prospective measurement of weight loss, lean body mass retention, and evaluation of wound healing. This is a preliminary examination of SR versus GRR, as we examined a very specific group, subjects who tolerated goal EN prior to the first E&G. Further investigation of other E&G surgeries other than the initial E&G, other surgeries, and subjects who tolerated less than goal EN would enhance the interpretation the promising results from this pilot study.

Disclaimer statement

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

This study was conducted under a protocol reviewed and approved by the U.S. Army Medical Research and Materiel Command Institutional Review Board and in accordance with the approved protocol.

Sources of support

The Clinical Trials in Burns and Trauma Task Area and the U.S. Army Institute of Surgical Research.

External funding

No funding was received from the National Institutes of Health (NIH), Wellcome Trust, or the Howard Hughes Medical Institute (HHMI).

Conflict of interest statement

Dr. Chung has a patent on a burn decision support system and a grant from the American Burn Association to conduct a multicenter study in patients with septic shock and renal failure. The other authors declare that they have no competing interests.

Acknowledgement

We would like to thank Ms. Otilia Sánchez for her assistance in editing this manuscript.

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